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THE FOSSILIFEROUS HORIZONS

The fossils which are used as a basis for this contribution were collected by the writer in the fall of 1905 and the early part of 1906. Mr. Charles D. Walcott visited the district in 1885, and discovered a very fossiliferous horizon which he has correlated with the Middle Cambric. He also gathered a supposed Lower Cambric fauna from a point about six miles east of Pioche. From both these places he obtained several forms that had not been previously described. He has recorded the results of his investigations in *Bulletin No. 30* of the United States Geological Survey. So far as the writer is aware, no other study has been made of this fauna.

Some interesting problems have arisen in the attempt to correlate the Pioche section with the horizons elsewhere. In America the Cambric of the eastern states has received by far the most attention; it has been divided into zones, each of which is represented by a characteristic fauna. The following subdivisions are generally recognized:

Upper Cambric—Dikellocephalus zone
Middle Cambric—Paradoxides zone
Lower Cambric—Olenellus zone

In Nevada the upper and the lower zones are represented by forms which are almost identical with those of similar horizons in the East, but the middle one is characterized by an almost entirely new series. Olenellus and Dikellocephalus are separated in every case by more than 1,000 feet of conformable strata, which carry in places the new forms and some old ones, none of which are elsewhere typically representative of any definite horizon. This condition has made correlation difficult; Walcott, however, has referred these formations to the Middle Cambric. Dr. G. F. Matthew does not concur in this opinion, but thinks that they properly belong to the Upper Cambric.

He further believes that a proper correlation would place the Olenellus fauna above the Paradoxides, and therefore at least as high as upper Mid-Cambric.[1] Throughout western America the Olenellus zone is preceded by thick quartzite beds, which Matthew believes are equivalent to the Protolenus and Paradoxides zones. Chamberlin and Salisbury state that "in the Hudson-Champlain valley the Olenellus fauna appears to have lived on until the advent of the Dikellocephalus fauna."[2] They consider it possible "that the Olenellus of the West and of the Hudson-Champlain valley may have been contemporaneous with the Paradoxides of the East," although they incline to the opinion that it was contemporaneous with the Holmia. At Newton, N. J., Mr. Stuart Weller found a supposed Olenellus species in the undoubted Dikellocephalus zone. In speaking of the value of this specimen, he says:

> It suggests the possibility of a much longer range for the genus Olenellus in geologic time than has been ascribed to it. This genus is usually considered as particularly characteristic of the very lowest Cambrian strata, but here it seems to be associated with the fauna which bears unmistakable marks of the upper Cambrian age.[3]

The exact stratigraphic position of the Olenellus zone is not therefore established. With our present knowledge it is impossible to state whether it is Upper or Lower Cambric, but it appears that Walcott's view is supported by the more evidence. The writer has collected several new forms, but they give no further information as to the position of this series. At present, however, we shall adopt the classification of Mr. Walcott.

In the Pioche Mountains the Lower and Middle Cambric only are represented; the Upper has been removed by erosion. Faulting has so complicated matters that a continuous section cannot be obtained, but one made up from different places is as follows:

5.	Limestone	800 feet
4.	Shale	75 "
3.	Limestone	600 "
2.	Shale	400 "
1.	Quartzite	1500 "

[1] *Transactions of the Royal Society of Canada*, 1899, Second series, Vol. V., pp. 67, 68.

[2] Chamberlin and Salisbury. *Geology*, Vol. II, p. 245.

[3] Geological Survey of New Jersey, *Paleontology*, 1902, Vol. III, p. 13.

The Olenellus fauna is confined to the lower 100 feet of No. 2, a part which is not exposed in the area covered by this report. Walcott gives the following list of fossils which he collected at a point five or six miles east of Pioche:

Eocystites?? longidactylus
Lingulella ella
Kutorgina pannula
Acrothele subsidia
Acrotreta gemma
Orthis highlandensis
Hyolithes billingsi
Olenellus gilberti
Olenoides levis
Crepicephalus augusta
Crepicephalus liliana

No. 4 of the section given above comprises the second strongly marked faunal horizon. It is best exposed in the Half Moon Gulch about two miles west of Pioche. It forms part of the south member of the anticline, and is nearly horizontal, although occasionally it is slightly tilted. Mining operators have thrown large quantities of this material over their dumps; it was from these places that most of the writer's fossils were collected. The shale also occurs near the city water-tank on the hill southwest of Pioche; the outcrop, however, is highly altered and consequently most of the fossils are destroyed. The following is a list of the species thus far obtained at this horizon:

Eocystites?? longidactylus
Lingulella ella
Kutorgina pannula
Hyolithes billingsi
Ptychoparia piochensis
Zacanthoides typicalis
Bathyuriscus productus
Bathyuriscus howelli
Lingulella genei
Ptychoparia kempi
Zacanthoides grabaui

DESCRIPTION OF SPECIES

ECHINODERMATA

GENUS EOCYSTITES, Billings

EOCYSTITES, Billings, 1868: *Acadian Geology*, p. 643, Fig. 220.

Eocystites?? longidactylus, Walcott

(Plate I, Figs. 1, 1*a*, 1*b*)

Eocystites?? longidactylus, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 94, Plates 5, 6.

In 1886 Mr. Walcott tentatively referred the species *longidactylus* to the genus Eocystites, awaiting a further description of *Eocystis*, Billings, (1868), and *Protocystis*, Hicks (1872). These forms, however, have never been properly described or figured, and, according to Bather, "since they cannot be well distinguished from *Eocystites* (*?*)

longidactylus, that species must be taken as an example of the genus." The most important features are: "the presence around the mouth of not less than ten biserial brachioles with long covering-plates ('short pinnulæ' of Walcott); the varying development of radiating stereom-folds on some of the plates;" the disposition of the plates "without apparent order, and varying in form, size, and surface characters on the same body." The specimens collected by Walcott are well preserved in some parts and badly crushed in others. Those in the writer's collection are in some respects very good; they do not, however, show all the features noted by Walcott, but in addition they possess some very interesting points not before revealed. Among these are a very primitive form of stem, and highly lobate plates.

The writer's collection of these species consists of several arms (all of which show the covering-plates), some loose plates, and a very beautiful specimen showing the lower part of the calyx with the stem attached. The plates are considerably misplaced, and the proximal part of the stem is somewhat crushed; otherwise the specimen is in a very good state of preservation. The drawing in Plate I is that of a cast.

None of the arms, with but one exception, shows the biserial nature of the brachioles; this may be due to the position from which they are viewed. Walcott observed one "pinnule" to each arm plate, but the writer's best-preserved specimen shows two to each plate (Fig. 1*a*).

As noted above, the plates are described as "numerous, disposed without apparent order, and varying in form, size, and surface characters;" and further, "the margin of many of the plates appears to be so indented as to have an opening or pore that passed into the central cavity." The plates in the writer's specimen are also numerous, of varying size, and are irregularly placed, but the surface characters described by Walcott are entirely absent. The plates are all smooth and slightly concave. The marginal indentions are carried so far that the plates are completely lobed (Fig. 1*b*). At first sight the lobes of the various plates appear to interlock, and thus form a rather rigid connection; but a closer examination has convinced the writer that this apparent interlocking is due to the intrusion of foreign material. Some few plates, however, appear to show this condition. It is probable that the plates were so arranged that only the

extreme ends of the lobes touched. They vary in size and form; in general outline many of them are decidedly hexagonal, others are pentagonal, and still others are nearly circular. The ones nearest the stem do not show the presence of lobes. The lobate plates closely resemble those of the embryonic Antedon.

The stem is composed of numerous sac-like plates, varying in size and irregularly placed (Fig. 1). The diameters of about eight of these appear to equal the circumference of the stem. The stem tapers slightly from the calyx down, and near the lower end turns gently to one side. It is probable that the stem was flexible throughout and possibly prehensile in the lower portion. The extreme tip is not revealed.

The greatest value of this fossil lies in the stem or pedicle. It is known that some of the primitive cystoids, as *Aristocystis* (Barrande, 1887), possess no stem whatever. Others, as *Dendrocystis* (Barrande, 1887), have a rudimentary stem, the plates of which are irregular near the calyx, but pass into comparatively large solid plates farther down. In such forms as *Trochocystis* (Barrande, 1859–87; syn. *Trigonocystis*, Haeckel) the stem is short and tapering and composed of regularly arranged plates. In the species under discussion the plates composing the calyx, as well as the stem, appear to have been arranged with no regularity whatever. *Eocystites? ? longidactylus*, therefore, appears to be the earliest form of stemmed cystoid yet described.

Location and formation: Two miles west of Pioche at the Abe Lincoln Mine, on the southwest slope of the mountains, in a pinkish shale of Mid-Cambric age.

PTEROPODA

GENUS **HYOLITHES**, Eichwald

HYOLITHES, Eichwald, 1840: *Sil. schicht. Syst. in Ehstl., p. 97.*

Hyolithes billingsi, Walcott

Salterella obtusa, Billings, 1861: *Geology of Vermont*, Vol. II, p. 955.

Hyolithes primoirdialis? White, 1874: *Geographical and Geological Exploration and Survey, West of the 100th Meridian*, Preliminary Report, Invertebrate Fossils, p. 6.

Hyolithes billingsi, Wallcott, 1886: *Bulletin No.* 30, U. S. Geological Survey, p. 134, Plate 13.

This form was not collected by the writer, although Walcott has described it from this locality.

BRACHIOPODA

GENUS LINGULELLA, Salter

LINGULELLA, Salter, 1861: *Memoir, Geological Survey of Great Britain*, p. 333.

Lingulella ella, H. & W.

(Plate 1, Figs. 2, 2a)

Linguelepsis ella, Hall and Whitefield, 1877: *Geological Exploration of the Fortieth Parallel*, Vol. IV, p. 232, Plate 1.

Lingulella ella, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 97, Plates 7, 8.

Walcott has recently described this form under the name *Obolus (Westonia) ella.* It is found in great abundance wherever the shale member is available, and is probably the best-preserved of any of the fossils.

Location: Himon Mine, Chisholm Mine, Half Moon Mine, and Abe Lincoln Mine.

Lingulella genei, n. sp.

(Plate I, Figs. 3, 3a, 3b)

Small shell, rarely exceeding 2^{mm} in length, elongate ovate or semielliptical; about one-fifth longer than broad; widest portion a little nearer the front which is broadly rounded. Dorsal valve generally ovate and rounded at the beak. Both valves moderately convex.

The interior cast of the dorsal valve is well marked by three scars, the middle one of which extends more than half-way toward the front, the outer ones not quite so far.

In general this species resembles *Lingulella granvillensis*, found at Whitehall, N. Y. It differs in the ovate form, in the surface markings, and in the muscular scars.

This fossil occurs abundantly in the shales at the Half Moon Gulch. It is associated with *Zacanthoides typicalis*, *Ptychoparia poichensis*, and *Eocystites?? longidactylus.* In fact, the writer has one slab carrying these four fossils. It is preserved in beds of pink and brown calcarous shale; the fossil is of the same color as the inclosing rock, but a little darker.

Location: Abe Lincoln Mine.

GENUS **KUTORGINA**, Billings

KUTORGINA, Billings, 1861: Pamphlet and *Geology of Vermont*, Vol. II, p. 948.

KUTORGINA, Davidson, 1871: *Manual of British Fossil Brachiopods*, Vol. III, p. 342.

Kutorgina pannula, White.

(Plate II, Figs. 1, 1*a*, 1*b*, 1*c*)

Trematis? pannula, White, 1874: *Geographical and Geological Exploration and Survey West of the 100th Meridian*, Preliminary Report "Invertebrate Fossils," p. 6.

Kutorgina pannula, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 105, Plates 7, 8.

The writer's collection contains but one specimen of this species, and it differs slightly from all of the forms thus far figured. In the genus *Kutorgina* the hinge line extends nearly the whole width of the shell. The outline of *K. pannula* is "apparently subcircular or a little broader than long; apex moderately pronounced and situated near the posterior margin." This condition, as well as the characteristic surface markings, are well shown in the specimen at hand. It differs chiefly from the ones described and figured in being larger and in having almost square shoulders. The writer has produced in outline Walcott's figures, which, with the one of the writer's, form a complete series, ranging from the type with very sloping shoulders to the one with square shoulders. This feature is accompanied with an increase in size.

Location: Abe Lincoln Mine.

CRUSTACEA

TRILOBITA

GENUS **BATHYURISCUS**, Meek

BATHYURISCUS, Meek, 1873: *Sixth Annual Report*, U. S. Geographical Survey of the Territories, p. 484.

Bathyuriscus howelli, Walcott

(Plate II, Figs. 2, 2*a*)

Bathyuriscus howelli, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 216, Plate 30.

Emblominus rotunda, Roem., 1887: *Proceedings of the Academy of Natural Sciences*, Philadelphia, 1887, p. 16, Pl. I.

The entire head of the creature has not been found. The pygidia, which occur in abundance, show considerable variation in form and

size. Walcott originally figured the head with three pairs of glabellar furrows, but it was later shown that four were present. The writer found two heads somewhat resembling the type. They differ from it mostly in the presence of a frontal margin, which is well developed in the antero-lateral portion. There are four pairs of well-defined glabellar furrows; the posterior pair points obliquely backward; the second pair points almost directly across; the third and fourth pairs point obliquely forward. The glabella is broadly expanded in front of the eyes. The postero-lateral limbs are not preserved. The two heads were collected at the Half Moon Mine. The writer tentatively refers them to this species.

Location: Himon Mine, Abe Lincoln Mine, Half Moon Mine.

Bathyuriscus productus, H. & W.

(Plate II, Figs. 3, 3*a*, 3*b*)

Ogygia producta, Hall & Whitefield, 1887: *Geological Exploration of the Fortieth Parallel*, Vol. IV, p. 244, Plate 2.

Bathyuriscus producta, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 217, Plate 30.

This species occurs in great abundance; its remains are largely fragmentary, the pygidia being the most common.

Location: Himon Mine and Abe Lincoln Mine.

GENUS **PTYCHORPARIA**, Corda

PTYCHOPARIA, Corda, 1847: *Prodram. Mon. böhm. Trilobiten*, p. 141.

Equals *Conocephalus*, Zenker, 1833.

Equals *Conocephalus*, Barrande, 1852.

Ptychorparia piochensis, Walcott

(Plate II, Figs. 4, 4*a*, 4*b*, 4*c*)

Ptychoparia piochensis, Walcott, 1886: *Bulletin No 30*, U. S. Geological Survey, p. 201, Plate 28.

This is a very characteristic form; it occurs throughout the entire shaly stratum, and usually is abundantly represented. The heads are most commonly preserved, but almost perfect fossils are frequently found. In all of the specimens figured by Mr. Walcott the frontal rim appears to bend downward. This is probably a fault of the drawing, as not a single form in the writer's collection shows this condition. The frontal margin turns somewhat abruptly *upward* into the frontal rim (Fig. 4*a*).

Location: Himon Mine, Chisholm Mine, Abe Lincoln Mine, Half Moon Mine, and at the upper water tank near Pioche.

Ptychoparia Kempi, n. sp.

(Plate III, Fig. 1.)

This form is known only by the head inside of the free cheeks.

General outline of the head moderately quadrate; width, exclusive of postero-lateral limbs, about equal to height. Glabella short, conical, with straight lateral sides converging from base forward to gently rounded front; slightly longer than one-half height of head; one and one-half times longer than posterior width; marked by three pairs of glabellar furrows, pointing directly across and nearly uniting at center; moderately well-marked occipital groove, which deepens into pit near lateral margin of glabella; occipital ring slightly convex, and provided with well defined knob, or perhaps spine.

Frontal limb broad, and concave toward front, where it turns slightly upward, forming a narrow frontal rim; half as high as wide; marked with fine stria radiating from front of glabella and extending about half-way to anterior rim; antero-lateral portion broadly rounded.

Fixed cheeks separated from glabella by deep dorsal furrows; elevated inside eye-lobe, and forming a cone or rounded pyramid the apex of which is nearly twice as high as glabella; anterior slope more gentle than posterior, which pitches abruptly down into postero-lateral groove; fixed cheeks moderately broad, slightly contracted just in front of eye, and then expanded into broad anterior limb.

Eyes narrow, reaching from front of glabella to opposite elevation on fixed cheek.

Postero-lateral limbs elongate, narrow, curving gently backward, and traversed part way out by groove.

The species *P. subcoronata* is a closely allied form, but *P. kempi* may be readily distinguished from it by the absence of the peculiar boss in front of the glabella, and by the presence of the elevations on the fixed cheeks.

The one specimen by which this form is known preserves only the glabella, frontal margin, free cheeks, and postero-lateral limbs. It is fairly well preserved, and is contained in a brown shale tinted with green.

Location: Half Moon Mine.

GENUS ZACANTHOIDES, Walcott

Zacanthoides, Walcott, 1888: *American Journal of Science*, Third Series, Vol XXXVI, p. 165.

Zacanthoides typicalis, Walcott

(Plate III, Figs, 2, 2*a*, 2*b*, 2*c*, 2*d*, 2*e*, 2*f*)

Olenoides typicalis, Walcott, 1886: *Bulletin No. 30*, U. S. Geological Survey, p. 183, Plate 25.

Zacanthoides typicalis, Walcott, 1888: *American Journal of Science*, Third Series, Vol. XXXVI, p. 165.

This is the most widely distributed and characteristic fossil of the Mid-Cambric horizon at Pioche. Several almost perfect specimens were collected. The heads, free cheeks, and fragments of the body are extremely abundant. The material at hand, however, differs in a number of details from the type specimen as figured, but these differences are not all constant, as there is considerable variation in the collection. The writer has found no specimen that shows the exact arrangement of the pleural lobes, as indicated in the figure of the type. It will be seen by reference to this figure[1] that from posterior to anterior each lobe overlaps the succeeding one. This is probably a fault of the drawing, as all the specimens at hand show the opposite condition.

Of the entire collection of no less than twenty-five free cheeks and the attached genal spines there is not one specimen comparable to those in the figure to which reference has just been made. The most common spine is much straighter, and makes a larger angle with the axial lobe (Fig. 2). Several others, somewhat resembling those of the type, show a decided outward flexure in the backward extension (Fig. 2*e*). There are three or four nearly perfect specimens, in which the genal spines pass back as far as the extremity of the pygidium. In this form the spines on the postero-lateral limbs are also unusually long (Figs. 2*b*, 2*c*). Another very spinose specimen shows the presence of a long spine on the next to the last pleural segment (Fig. 2*d*). These conditions are rather confusing, as otherwise the specimens are all alike. The differences, however, can hardly be considered sufficient to justify the making of a new species. It may be that these variations in spinosity are simply sexual peculiarities, as suggested by Barrande in the case of *Paradoxides harlani*.

Location: Half Moon Mine, Chisholm Mine, Abe Lincoln Mine, and at the upper water-tank above Pioche.

[1] *Bulletin No. 30*, U. S. Geological Survey, Plate 25, Fig. 2.

Zacanthoides grabaui, n. sp.

(Plate III. Figs. 3, 3*a*, 3*b*)

This species is known only by the head, free cheeks, and some fragments of the thoracic segments with spines attached. Two of the specimens (Fig. 3 b) were collected by Mr. Charles Of.

General form of the head triangular; glabella elongate, a little more than twice as long as broad; sides parallel; front broadly rounded; surface moderately convex; slight ridge extending lengthwise at summit; three pairs of well-marked glabellar furrows, the posterior pair pointing obliquely backward, the second pair directly across, and the anterior pair slightly forward; occipital furrow fairly well marked, and occipital ring provided with a knob or spine; postero-lateral limb provided with short thick spine.

Frontal margin expanded into broad triangular area, one of the apices pointing directly forward; rim on either side of anterior apex slightly concave backward; triangular area, provided with well-pronounced frontal rim; area flat with slight elevation near center; marked with stria radiating from front of glabella; frontal rim marked with fine stria extending longitudinally.

Fixed cheeks moderately broad inside on the eye-lobe, highly contracted just beyond front of eye, and then expanded into triangular frontal margin.

Free cheeks broad and flat, bordered anteriorly and laterally by heavy rim extending backward into a slightly curved genal spine, which apparently does not pass beyond the fifth thoracic segment.

Eyes narrow and long, reaching from opposite anterior pair of glabellar furrows to opposite occipital ring.

Axial lobe apparently same width as glabella, and rather highly convex; first pleural lobe extends through an abrupt angle into a short stout spine; in the second the spine is longer and the angle less abrupt; in the third the angle disappears, the lobe and spine forming a gentle curve.

In some ways this form resembles *Z. typicalis*, but differs from it in the general shape of the head, the frontal margin, and the genal spines.

Location: Half Moon Mine.

PLATE I

FIG. 1.—*Eocystites?? longidactylus*, Walcott.

1. View of specimen showing the sac-like stem and the lobed plates; twice natural size. Collection Columbia University Museum, No. 20001.

1*a*. An arm showing the arrangement of the covering-plates; twice natural size. Collection Columbia University Museum, No. 20002.

1*b*. Slightly concave plate showing the lobate arrangement at margin; four times natural size. Collection Columbia University Museum, No. 20003.

FIG. 2.—*Lingulella ella*, H. &. W.

2. View of a well-preserved specimen; twice natural size. Collection Columbia University Museum, No. 20004.

2*a*. Elongate specimen; twice natural size. Collection Columbia University Museum, No. 20005.

FIG. 3.—*Lingulella genei*, n. sp.

3. View of dorsal valve showing distribution of the concentric lines; seven times natural size. Prototype. Collection Columbia University Museum, No. 20006.

3*a*. Ventral valve; seven times natural size. Paratype. Collection Columbia University Museum, No. 20006.

3*b*. Internal mold of dorsal valve; seven times natural size. Paratype. Collection Columbia University Museum, No. 20002.

PLATE II

FIG. 1.—*Kutorgina pannula*, White.

1. View of a large square-shouldered specimen; twice natural size. Collection Columbia University Museum, No. 20009.

1*a*. Outline drawing of type specimen as figured in *Bulletin No. 30*, U. S. Geological Survey.

1*b*, 1*c*. Outline drawings of specimens as figured in *Bulletin No. 30*, U. S. Geological Survey.

FIG. 2.—*Bathyuriscus howelli*. Walcott.

2. Specimen showing the four pairs of pleural grooves extending nearly to the margin; natural size. Collection Columbia University Museum, No. 20011.

2*a*. Specimen tentatively referred to this species; it shows four pairs of glabellar furrows, also well-developed antero-lateral frontal margin; twice natural size. Collection Columbia University Museum, No. 20012.

FIG. 3.—*Bathyuriscus productus*, H. & W.

3. View of well-preserved head, natural size. Collection Columbia University Museum, No. 20014.

3*a*. View of pygidium showing well-defined, broad, flattened border; no rings on axis; natural size. Collection Columbia University Museum, No. 20015.

3*b*. View of pygidium showing rings on axis; border not so flat as in 3*a*; natural size. Collection Columbia University Museum, No. 20016.

FIG. 4.—*Ptychoparia piochensis*, Walcott.

4. View of typical specimen; twice natural size. Collection Columbia University Museum, No. 20018.

4*a*. View of typical head showing the elevated frontal rim; twice natural size. Collection Columbia University Museum, No. 20019.

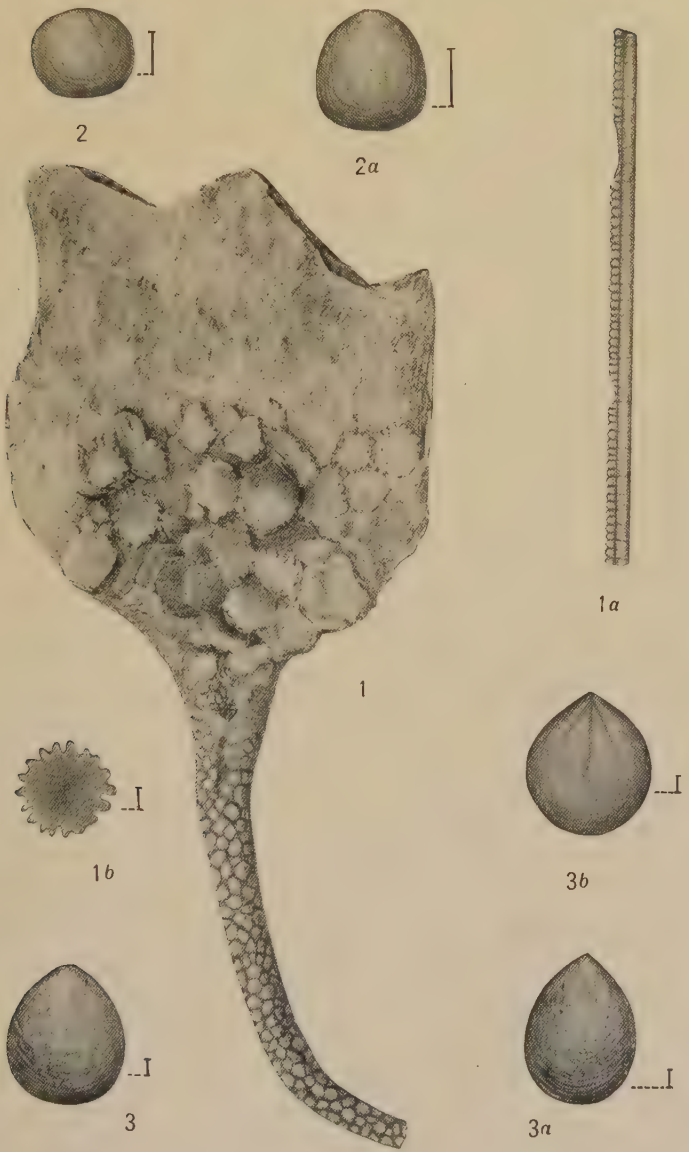
4*b*. View of free cheek; natural size. Collection Columbia University Museum, No. 20020.

4*c*. View of what appears to be an hypostoma with doublure attached; twice natural size. Collection Columbia University Museum, No. 20021.

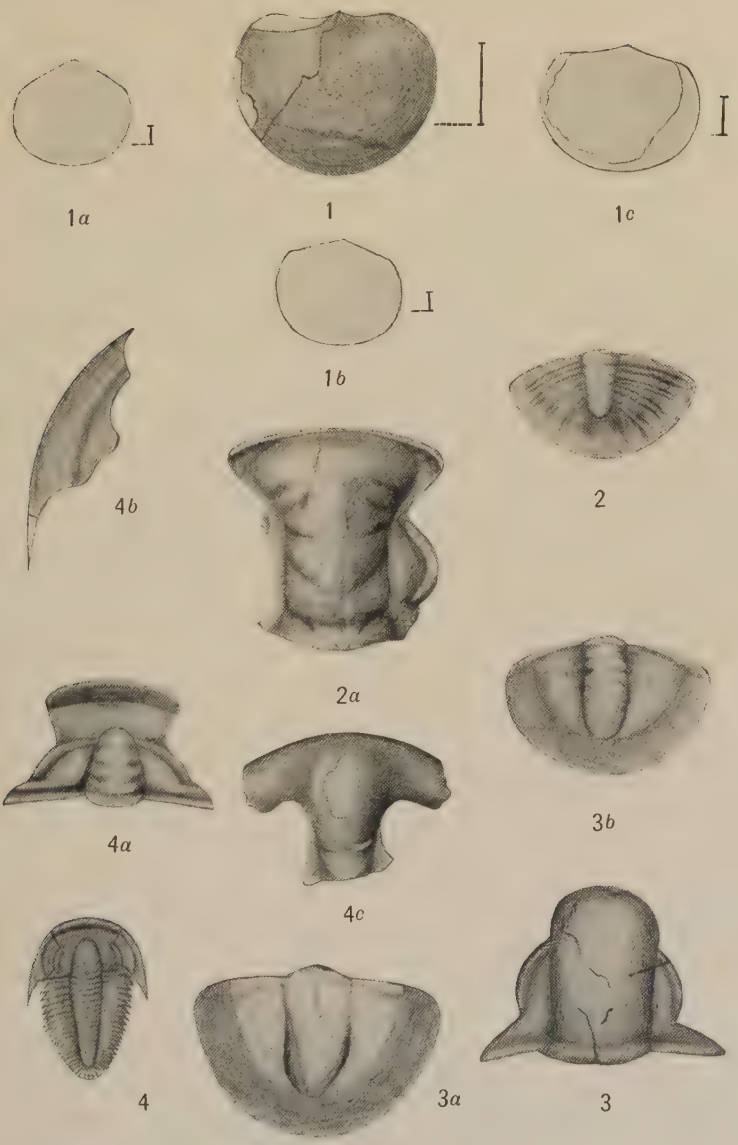
PLATE III

FIG. 1.—*Ptychoparia kempi*, n. sp.

1. View of prototype showing character of frontal margin and elevations inside eye-lobe; natural size. Collection Columbia University Museum, No. 20023.



F. J. Pack and R. B. Johnson, Del.



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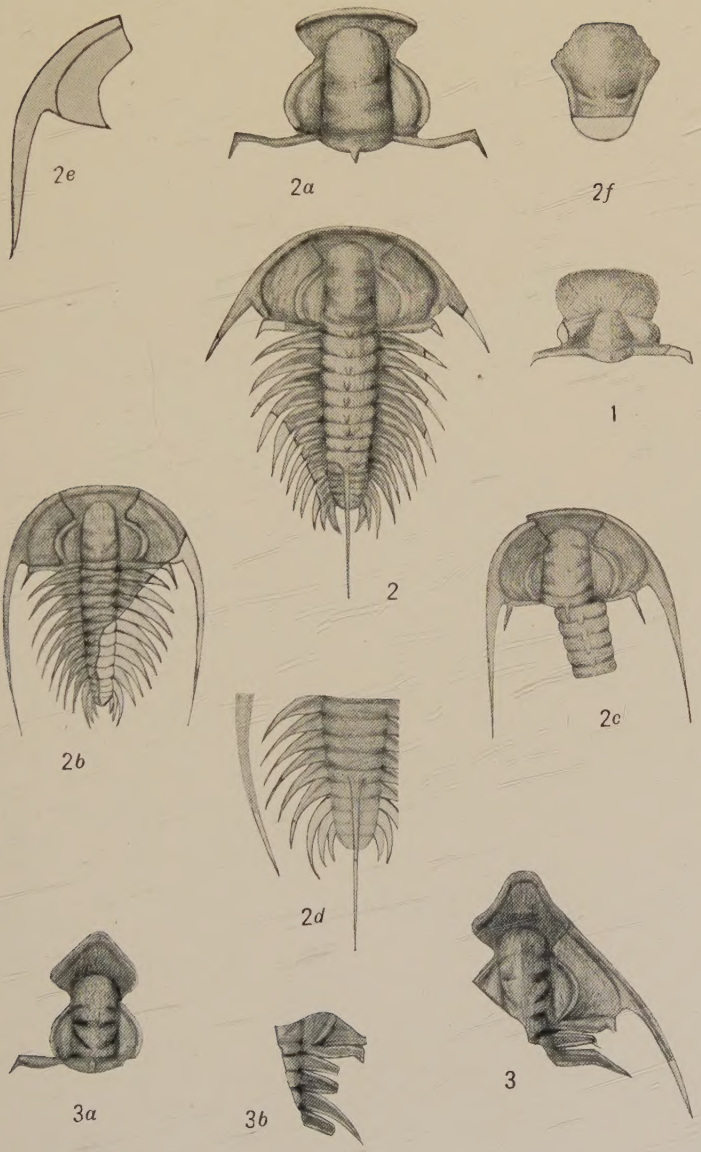

F. J. Pack, Del.

FIG. 2.—*Zacanthoides typicalis*, Walcott.

2. View of specimen closely resembling the type; twice natural size. Collection Columbia University Museum, No. 20024.

2*a*. View of head showing the postero-lateral limbs attached; twice natural size. Collection Columbia University Museum, No. 20025.

2*b*. Specimen showing remarkably long genal spines, long spines on postero-lateral limbs, but, so far as revealed, no spines on thoracic segments; twice natural size. Collection Columbia University Museum, No. 20026.

2*c*. Specimen showing considerable spinocity, twice natural size. Collection Columbia University Museum, No. 20027.

2*d*. Specimen with long genal spines, also long spine on the next to the last thoracic segment; natural size. Collection Columbia University Museum, No. 20028.

2*e*. Very commonly associated free cheek showing outward flexure toward the end of spine; twice natural size. Collection Columbia University Museum No. 20003.

2*f*. Hypostoma associated with this species; natural size. Collection Columbia University Museum, No. 20029.

FIG. 3.—*Zacanthoides grabaui*, n. sp.

3. Prototype showing the general form of head, triangular frontal margin, and nearly straight genal spines; natural size. The free cheek has been slightly adjusted. Collection Columbia University Museum, No. 20031.

3*a*. Paratype showing the general nature of the head, also the knob or spine on the occipital ring; natural size. Collection Columbia University Museum, No. 20031.

3*b*. Cast of paratype showing nature of third pleural lobe and the attached spine, natural size. Collection Columbia University Museum, No. 20032.